Utah Department of Transportation

Supplemental Specifications for

2005 Standard Specifications

FOR ROAD AND BRIDGE CONSTRUCTION

U.S. Standard Units (Inch-Pound Units)

Issued May 2, 2006

Memorandum

UTAH DEPARTMENT OF TRANSPORTATION

DATE: May 2, 2006

TO: Holders of Hard Copy of Standard Specifications

FROM: Barry Axelrod, CDT
Standards and Specifications

SUBJECT: Supplemental Specifications Distribution, dated May 2, 2006

Applicable files for the change are attached. Maintain these files as a supplemental update to the UDOT Standard Specifications dated January 1, 2005. No pages are to be removed or replaced in the basic book, electronic or hard copy.

If you are in need of electronic copies of any Standard or Supplemental Specification please refer to the Standards and Specifications Web site at http://www.udot.utah.gov/index.php?m=c&tid=302. From there select the **2005 Standards** subtopic.

Please note that the 2005 Standards are still in effect. There is no plan to issue a new set of Standards for a 2006 version.

If you have any questions or problems with the electronic files contact me at 801-964-4570 or by email at **baxelrod@utah.gov.**

Attachments

Listing of Supplemental Specifications

Issue Date: March 14, 2005

Revised February 24, 2005

- Section 01282M Article 1.1 Paragraph D added and Article 1.14 Paragraph E replaced.
- Section 01284 New section added
- Section 02785M Replaces Table 1 to correct reference callout from AASHTO to ASTM
- Section 02843 Entire section revised.
- Section 06055M Article 1.2 Paragraph F added and Article 2.2 Paragraphs A and D modified.

Issue Date: May 10, 2005

Revised April 28, 2005

- Section 02827 New section added

Issue Date: July 12, 2005

Revised June 30, 2005

- Section 02745 Entire section revised.
- Section 03412M Article 1.3 revised, Article 1.4 Paragraph E added, Article 1.5 Paragraph C added, and Article 3.7 added.
- Section 05120 M Article 1.3 revised, Article 1.4 Paragraph D added, and Article 3.5 added.

Issue Date: September 12, 2005

Revised August 25, 2005

- Section 01452M Article 3.1 Paragraph B item 1 replaced.
- Section 01571 Entire section replaced.
- Section 01574M Article 1.1 replaced, Article 1.3 Paragraph B added, and Article 3.1 Paragraphs F and G added.
- Section 01721M Article 1.2 replaced.
- Section 02842M Article 1.3 Paragraph C and Article 2.1 Paragraph A replaced.
- Section 13551M Article 1.3 replaced, Article 2.1 replaced, Article 3.3 Paragraph C replaced, Article 3.5 Paragraph C replaced, and Article 3.5 Paragraph D added.
- Section 13552M Article 1.1 Paragraph A replaced, Article 1.3 replaced, Article 2.2 through Article 2.6 replaced, Article 2.8, Paragraph C added, and Article 3.2 replaced.

Section 13553M Article 1.2 paragraphs I and J replaced, Article 1.3 replaced, Article 2.1 Paragraphs H and I replaced, Article 3.1 Paragraph F replaced, Article 3.1 Paragraph Q3 replaced, Article 3.2 Paragraph A replaced, Article 3.3 Paragraph F replaced, Article 3.4 Paragraph C added, and Article 3.5 Paragraph C added.
Section 13554M Article 2.2 replaced and Article 3.1 Paragraph N through H replaced.
Section 13555M Article 1.3 Paragraph E added, Article 2.1 Paragraph A replaced, Article 3.1 Paragraph D deleted, Article 3.2 Paragraphs C, G, and H replaced, Article 3.4 replaced, and Article 3.6 Paragraphs A and B replaced.
Section 13556 Entire section revised.
Section 13561M Article 2.1 Paragraph K added, Articles 3.1 Paragraphs E through G replaced, and Article 3.2 Paragraph A replaced.
Section 13594M Article 2.3 Paragraph A replaced, Article 2.3 Paragraph C replaced, Article 2.4 replaced.

Issue Date: November 9, 2005

Revised October 27, 2005

Section 00725M Article 1.2, paragraph B added, Article 1.4 replaced.
Section 02745 Entire section originally revised July 12, 2005. This change corrected error in Table 13, Float Test.

Issue Date: March 2, 2006

Revised February 23, 2006

Section 00555M Article 1.6, paragraph A replaced.
Section 00725M Article 1.2, paragraph B added, Article 1.4 replaced, Article 1.18 Paragraph C1 added, article 1.18 Paragraph D replaced, and Article 1.18 Paragraphs E – I replaced. **(Replaces Supplemental Specification 00725M issued November 9, 2005.)**
Section 00820M Article 1.2 replaced, Article 1.15 replaced, and Article 1.16 replaced.
Section 01280M Article 1.3 replaced and Article 1.10 deleted.
Section 01574M Article 1.1 replaced, Article 1.3 Paragraph B added, Article 1.4, paragraph B1 added, Article 3.1 Paragraphs F and G added, and Article 3.4, paragraph A replaced. **(Replaces Supplemental Specification 01574M issued September 12, 2005.)**
Section 01721M Article 1.1, Paragraph A replaced, Article 1.2 replaced, Article 1.5, Paragraph F and G replaced, Article 3.3, Paragraph C deleted, and Article 3.11 replaced. **(Replaces Supplemental Specification 01721M issued September 12, 2005.)**
Section 02317 Entire section revised.
Section 02748M Article 2.1, Paragraph A replaced, Article 2.2, Paragraph A replaced, and Article 3.2 replaced.

Issue Date: May 2, 2006

Revised April 27, 2006

Section 02633 New section added.

Section 13557 Entire section revised. Title changed.

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SECTION 02633

CONCRETE DRAINAGE STRUCTURES

Add Section 02633:

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Materials and procedures for constructing concrete drainage structures from the CB and DB Series Standard Drawings.

1.2 RELATED SECTIONS

A. Section 01721: Survey

B. Section 02324: Compaction

C. Section 02635: Grates, Solid Covers, Frames, and Manhole Steps

D. Section 03055: Portland Cement Concrete

E. Section 03056: Self-Consolidating Concrete (Special Provision)

F. Section 03152: Concrete Joint Control

G. Section 03211: Reinforcing Steel and Welded Wire

H. Section 03310: Structural Concrete

I. Section 03390: Concrete Curing

1.3 REFERENCES

A. AASHTO M 198: Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets

B. AASHTO M 199: Precast Reinforced Concrete Manhole Sections

C. AASHTO M 213: Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

D. AASHTO M 235: Epoxy Resin Adhesives

E. AASHTO M 315: Joints for Circular Concrete Sewer and Culvert Pipes Using Rubber Gaskets

F. AASHTO Standard Specification for Highway Bridges

G. ASTM C 361: Standard Specification for Reinforced Concrete Low-Head Pressure Pipe

H. ASTM C 443: Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

I. ASTM C 478: Precast Reinforced Concrete Manhole Sections

J. ASTM C 857: Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

K. ASTM C 858: Standard Specification for Underground Precast Concrete Utility Structures

L. ASTM C 891: Installation of Underground Precast Concrete Utility Structures

M. ASTM C 1107: Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

N. ASTM C 1244: Standard Test Method for Concrete Sewer Manholes by Negative Air Pressure (Vacuum) Test Prior to Backfill

O. UDOT Quality Management Plans

1.4 DEFINITIONS

A. This specification is applicable for the following defined products:
   1. Catch Basin/Drop Inlet: A structure accepting drainage from gutters or medians or other channels and discharging the water through a conduit. Refer to the CB and DB Series Standard Drawings for shape and dimensions of Standard Catch Basins.
   2. Inlet: A grated surface connection to a closed conduit such as a storm drain. A structure at the upstream end of a cross culvert. The upstream end of any structure through which water may flow.

3. Manhole (access hole): A circular structure for access and joining pipes. Refer to the CB Series Standard Drawings for the Standard Detail for a Manhole.

1.5 SUBMITTALS

A. Submit concrete mix design for approval in accordance with Section 03055 or 03056 (Special Provision).

B. Precast structures:
   1. Provide verification the structures are furnished by a Department pre-qualified precast supplier.
   2. Submit a Certificate of Compliance from UDOT Central Materials upon delivery to the project.

1.6 ACCEPTANCE

A. Construct cast-in-place or install precast drainage structures meeting the requirements of this section and all other applicable requirements.

B. Repair or replace any structure that has the following:
   1. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the thickness of the precast unit.
   2. Defects showing improper proportioning, mixing, or molding.
   3. Honeycombing and open texture.
   4. Damaged or cracked ends that prevent joining manhole/inlets grade rings and sections.
   5. Any continuous crack having a surface width of 0.01 inch or more that extends more than 12 inches anywhere on the wall.
   6. For grade rings or similar structures limit cracks or fractures according to ASTM C 478.

   Submit repair procedure to the Engineer for approval prior to performing any repairs.

C. Precast structures:
   1. Furnish precast drainage structures in conformance with the CB Series Standard Drawings.
      a. Pre-qualify the supplier in accordance with the UDOT Quality Management Plan: Precast/Prestressed Concrete Structures.
      b. Furnish precast structures that are plumb and square within 1/8 inch per foot so that precast adjoining elements fit.
      c. Mark structures with date of casting and supplier identification.

D. Upon completing each installation, and before placing backfill, obtain acceptance from the Engineer.
   1. Verify the structures and pipe connections appear watertight.
   2. When directed by the Engineer, test in accordance with this Section, article 3.3.

PART 2 PRODUCTS

2.1 CONCRETE

A. Wet cast: Class AA-AE, see Section 03055.

B. Dry cast: Submit mix design for approval.
   1. Minimum cement content: 470 lb/yd^3
   2. Maximum water/cementitious ratio: 0.4

C. Self-Consolidating Concrete: Follow Section 03056 (Special Provision).

2.2 REINFORCING STEEL AND WELDED WIRE

A. Refer to Section 03211.

B. Use coated reinforcing steel.

2.3 STRUCTURAL CONCRETE

A. Refer to section 03310.

2.4 JOINTS AND SEALERS

A. Preformed Joint Filler: AASHTO M 213 and AASHTO M 198.

2.5 WATERSTOPS

A. Refer to Section 03152 for materials requirements.

B. Refer to AASHTO Standard Specification for Highway Bridges, Division II, Subsection 8.9.3.4 for installation requirements.

2.6 NON-SHRINK GROUT

A. Use non-shrink grout conforming to ASTM C 1107.

2.7 CURING COMPOUND

A. Refer to Section 03390.

2.8 FORMS

A. Use plywood, wood, metal, glass, or a combination of these materials.

2.9 GASKETS AND JOINT SEALANTS FOR CONNECTING PRECAST SECTIONS

A. Furnish gaskets for sealing precast sections that meet ASTM C 443 requirements.

B. Furnish gaskets for sealing precast concrete manholes that meet AASHTO M 315.

C. Furnish epoxy resin adhesive according to AASHTO M 235.

D. Furnish "O" Ring per ASTM C 361 as shown in the CB Series Standard Drawings.

2.10 MANHOLE/FRAME GASKET

A. Place ¾ inch diameter minimum extruded rope Type B flexible plastic gaskets between the manhole frame and the concrete risers that meet AASHTO M 198 requirements.

2.11 JOINTING MASTIC

A. Furnish a water resistant elastic jointing mastic of plastic bituminous materials and inert fillers that when applied to a vertical metal surface and heated to 120 degrees F does not loose slump or plasticity.

B. Furnish joint mastic that can be applied evenly and adhere at temperature range of 40 to 120 degree F or higher.

2.12 GRATES, SOLID COVERS, FRAMES, AND MANHOLE STEPS

A. Refer to Section 02635.

PART 3 EXECUTION

3.1 PREPARATION

A. Before manufacturing or constructing any structure, verify and ensure fit and function with field conditions. Refer to Section 01721.

B. Furnish structures free of voids, cracks, and with beveled corners and edges. Securely attach all inserts in the proper location. Prevent cold joints in the structure.

C. Clean and prepare the mating surfaces before assembly of pipes with structure.
   1. For precast, use one of the following methods to connect the pipe(s) to the structure:
      a. Pipe boot according to pipe manufacturer specifications for pipe type.
      b. Non-shrink grout to seal the pipe connection.

D. Excavate the material under the box location to a minimum depth of 4 inches, and backfill with suitable backfill material and compact.
   1. Excavate sufficiently to place and compact bedding and backfill material in accordance with Section 02324.
   2. Add as needed a sand-leveling course no greater than 2 inches in depth to the backfill material. When used, excavate the area to the appropriate depth to accommodate the backfill and leveling course.

3.2 INSTALLATION

A. Manholes: Furnish precast concrete manholes that conform to CB Series Standard Drawings, meet ASTM C 478 requirements, and have self-centering watertight joints that meet ASTM C 443 requirements.

B. Grade Rings/Catch Basin Grade Sections: Furnish grade rings or catch basin grade adjustment according to ASTM C 478, with anchor bolt-holes as shown on the CB Series Standard Drawings.

C. Precast Inlets and Boxes:
   1. Furnish structures conforming to CB Series Standard Drawings.
      a. Attach and secure all inserts at the place of manufacture such as wall sleeves, gaskets or piping, sumps, steps, access hatches, and any other inserts as shown on the plans or CB Series Standard Drawings.

2. Manufacture structures according to applicable requirements of ASTM C 858, and as modified by this Section.
    a. Meet AASHTO M 199 and ASTM C 857 requirements.
3. Provide sufficient lifting points for a safe installation.
    a. Locate lifting devices to avoid interference with the reinforcing steel.
4. Do not move precast units until after 28-day compressive strength has been attained.
    a. Protect the unit from any damage. Replace unacceptable units at no additional cost to the Department.
5. Follow ASTM C 891. Comply with manufacturer installation guidelines.
    a. Inspect precast drainage structures for defects before lowering into excavation.
    b. Clean mating surfaces of all foreign materials such as dirt, mud, stones, etc. and apply proper joint sealing material where applicable.
    c. Assemble all joints tightly.
    d. Use care when joining precast elements in cold weather. Do not force joints together with mechanical equipment. Sufficiently warm all sealing materials to flow without causing damage to precast joint elements.
6. Furnish structures with appropriate openings for connecting pipe.
    a. Cast or cut structure openings. Do not expose reinforcing steel or reduce reinforcing steel covering at openings.
    b. Do not modify precast units in the field by cutting or enlarging holes or by making any other changes without the manufacturer's and Engineer's approval.
    c. Modify precast units only according to manufacturer requirements.
7. Do not place precast drainage structure in excavation that has water and frozen surfaces.
8. Plug lift insert recesses with a 1:1 sand to cement grout mix. Finish flush with top and/or bottom surface of concrete.

3.3 TESTING

A. At the direction of the Engineer, upon failure of the visual inspection referenced in this Section, article 1.6, conduct either of the following tests to verify the drainage structures are watertight. Furnish all necessary equipment and materials. Repair and re-test at no additional cost to the Department any structures that fail any tests. Do not conduct Vacuum and Ex-filtration tests concurrently.

B. Vacuum Test: Follow the test procedure outlined below:

1. Vacuum test precast structures after assembly and prior to backfilling.
   a. Form a seal between the vacuum base and the manhole rim/precast structure cover. Secure pipe plugs to prevent movement while the vacuum is drawn.
   b. Draw a vacuum of 10 inches of mercury (Hg). Record the time for the vacuum to drop to 9 inches.
   c. Passing drop rates for the time to drop to 9 inches are as follows:

Diameter/Width	Time to Drop 1 inch Hg
up to 4 ft.	30 seconds
up to 5 ft.	40 seconds

   d. Make necessary repairs if the structure fails the test. Repairs and repair procedures must be acceptable to the Engineer.
   e. Disassemble the manhole and replace the gaskets if preformed plastic gaskets are pulled out during the vacuum test.

C. Ex-filtration Test: Follow test procedure ASTM C 1244 as modified below:

1. Plug all pipes leading into or out of the precast structure for a watertight seal.
2. Fill precast structure with water to a level three to four inches below the casting rim or lid.
3. Let the water stand for two-hours prior to beginning the test to allow absorption into the precast structure.
4. After the two-hour stabilization, place additional water to bring the water level back to three to four inches below the rim or lid.

5. Test for at least 2 hours and verify the leakage is less than shown on table 1.

Table 1

Precast Structure Ex-Filtration Test – Allowable Leakage						
Water Depth (measured from invert to water level)	**Allowable water drop per hour**					
(feet)	Maximum Horizontal Internal Dimension					
	4 ft.*		5 ft *		6 ft *	
	(gals)	(inches)	(gals)	(inches)	(gals)	(inches)
2	0.8	0.32	1.0	0.40	1.2	0.48
4	1.6	0.64	2.0	0.8	2.4	0.96
6	2.4	0.96	3.0	1.21	3.6	1.45
8	3.2	1.29	4.0	1.61	4.8	1.93
10	4.0	1.61	5.0	2.01	6.0	2.42
12	4.8	1.93	6.0	2.42	7.2	2.90
14	5.6	2.25	7.0	2.82	8.4	3.38
16	6.4	2.58	8.0	3.22	9.6	3.87
18	7.2	2.90	9.0	3.63	10.8	4.35
20**	8.0	3.22	10.0	4.03	12	4.84
* Adjust volume loss proportionally for different size not shown ** For greater depths provide an engineering analysis for equivalent ex-filtration rates.						

D. The Department will reimburse the Contractor for the actual cost of testing, not to exceed $500 per test, for each test required by the Engineer meeting vacuum or exfiltration requirements.

END OF SECTION

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SECTION 13557

VARIABLE MESSAGE SIGN AND SUPPORT

Delete Section 13557 and replace with the following:

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Install and test all Department furnished items including VMS sign assembly, VMS access platform, ATMS cabinet, and VMS controller.

B. Furnish, install, and test VMS support structures, sign connection hardware, catwalk, cabinet foundation, communications cable and any additional equipment required. Furnish all incidental items required to provide a complete cable connection between VMS controllers. Test the installed VMS and adjust the viewing angle as required.

1.2 RELATED SECTIONS

A. Section 01554: Traffic Control

B. Section 02466: Drilled Caisson

C. Section 03055: Portland Cement Concrete

D. Section 03211: Reinforcing Steel and Welded Wire

E. Section 03310: Structural Concrete

F. Section 05120: Structural Steel

G. Section 13551: General ATMS Requirements

H. Section 13554: Polymer Concrete Junction Box

I. Section 13555: ATMS Cabinet

J. Section 13595: ATMS Integration

1.3 REFERENCES

A. AASHTO M 31: Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

B. AASHTO M 232: Zinc (Hot-dip Galvanized) on Iron and Steel Hardware (nuts, washers, and anchor bolts)

C. AASHTO M 270: Carbon and High-Strength Low-Alloy Structural Steel Shapes, Plates, and Bars and Quenched and Tempered Alloy Structural Steel Plates for Bridges

D. AASHTO M 284: Epoxy Coated Reinforcing Bar

E. AASHTO M 291: Carbon and Alloy Steel Nuts

F. AASHTO M 293: Hardened Steel Washers

G. AASHTO M 314: Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

H. AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 4th Edition, 2001, with Interim

I. ASTM A 53: Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

J. ASTM A 123: Zinc (Hot-dip Galvanized) Coatings on Iron and Steel Hardware

K. ASTM A 307: Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

L. ASTM B 221: Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

M. ASTM B 308: Aluminum-Alloy 6061-T6 Standard Structural Profiles

N. ASTM B 429: Aluminum-Alloy Extruded Structural Pipe and Tube

O. ASTM F 593: Stainless Steel Bolts, Hex Cap Screws, and Studs

P. ANSI/AASHTO/AWS Structural Welding Code Specifications

1.4 SUBMITTALS

A. Mill Certificates for all structural steel. Refer to Section 05120.

B. Shop Drawings for all structure steel. Refer to Section 05120.

C. Provide all of the following submittals as described in Section 13551:
   1. Contractor Furnished Material and Equipment Lists
   2. Test Reports for the Cable & Conductor Test, the Local Field Operations Test, and the Thirty-Day Burn-In Test
   3. Completion Notice
   4. Compliance Certificate
   5. Manufacturer's Equipment Documentation
   6. As-Built Drawings

D. Provide item number and name on all materials certificates.

PART 2 PRODUCTS

2.1 VMS FOUNDATIONS

A. Concrete: Class AA(AE) required. Refer to Sections 03055 and 03310.

B. Reinforcing Steel: Use coated deformed billet-steel bars in accordance with AASHTO M 284 or ASTM A 123 and AASHTO M 31 Grade 60. Refer to Section 03211.

C. Anchor Bolts:
   1. In accordance with AASHTO M 314 Grade 36. Refer to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, Section 5.17.
   2. Thread the anchor bolts where shown and allow free running nuts, by hand, for the entire length.
   3. Galvanize the anchor bolts, all nuts and washers, in accordance with AASHTO M 232.
   4. Do not weld anchor bolts to reinforcing steel.
   5. Nuts: Use AASHTO M 291 Specifications.
   6. Washers: Use AASHTO M 293 Specifications.

2.2 JUNCTION BOX

A. Refer to Section 13554.

2.3 VMS SUPPORTS

A. Structural Steel: General
   1. Hot-dip galvanize all structural steel after fabrication in accordance with ASTM A 123. Structural steel may be metallized using electric arc sprayed zinc wire as an alternative.
   2. Welding: In accordance with the ANSI/AASHTO/AWS D1.1 Specifications.
   3. Galvanize all bolts, nuts, and washers in accordance with AASHTO M 232.
   4. Charpy V-Notch tests are required for all main load carrying tension members with a ½-inch steel thickness or greater. Test results must meet requirements for zone 2.

B. Structural Pipe:
   1. Use low carbon steel conforming to ASTM A 53 Grade B, except use chemical composition requirements of: carbon ≤ 0.25 percent, phosphorus ≤ 0.04 percent, manganese ≤ 1.35 percent, and silicon ≤ 0.05 percent. Use ASTM A 53 Grade B for other elements.
   2. Bolts, nuts, and washers: Refer to Section 05120.

C. All Other Structural Steel:
   1. All other shapes and plates: Use AASHTO M 270 Grade 36.
   2. Bolts: Use ASTM A 307.
   3. Stainless Steel Bolts: Use ASTM F 593 Type 304.
   4. Nuts: Use AASHTO M 291.
   5. Washers: Use AASHTO M 293. Use lock washers on all bolts.
   6. Galvanize entire sign assembly with mounting brackets: ASTM A 123.

2.4 VMS CATWALK

A. Aluminum: General
   1. Use 6061-T6 aluminum in accordance with:
      a. ASTM B 308 for I-beams, H-beams, channels, angles, tees, and zees.
      b. ASTM B 429 for pipe and tube.
   2. Grating: Use 5052 H32 aluminum expanded metal conforming to ASTM B 221 with the size shown in the contract.

3. Welding: In accordance with the ANSI/AASHTO/AWS D1.2 Specifications.

PART 3 EXECUTION

3.1 PREPARATION

A. Load, transport, and install all state-furnished materials per the manufacturer's instructions and as shown in the contract.

B. Provide foundations, VMS supports, junction boxes, ground rod, grounding lug, conduit, and all additional miscellaneous items required for a complete and operational VMS.

C. Install all wiring, conduit, and junction boxes as shown in the contract.
1. Field locate all conduit and junction boxes to avoid drainage areas and steep slopes whenever possible.
2. Protect existing conductors while installing cables and conductors.
3. Install surge suppressors at the VMS Sign Controller and ATMS Cabinet. Minimum specifications for surge suppressors are as follows:
   a. Protects Pairs 1-8
   b. Protects all Pins (8)
   c. Maximum Surge of 100 mA
   d. Turn on at 10 mA
   e. Typical Capacitance of 55 pF
   f. Series Resistance less than 0.02 Ω
   g 0 to 100 percent Humidity
   h. Operates in -40 degrees F (-40 degrees C) to 185 degrees F (85 degrees C) Temperatures

D. Furnish and install all incidental items, such as wire nuts, grommets, tape connectors, and electrical nuts, necessary to make the VMS system complete.

E. After installation, the exterior of all equipment must be free of all loose rust and mill scale, dirt, oil, grease and other foreign substances.

F. Restore work area to the original condition or better after work is completed.

3.2 CONSTRUCTION SEQUENCE

A. Deploy traffic control devices and/or personnel. Refer to Section 01554.

B. Fabricate structural supports and catwalk. Construct foundations, establishing base plate elevations in accordance with project plans. Obtain Engineer's approval for all dimension changes.

C. Survey the constructed base plate locations, have the Engineer approve their layout before erecting the sign structure, fit the structure to the foundations' anchor bolts, and meet vertical clearance requirements.

D. Remove shipping supports and connect all wiring and cables in a neat and orderly fashion, verify all parts are properly seated and functional and make final adjustments to sign horizontal and vertical angles. Orient the VMS sign perpendicular to the viewing angle of motorists 800 feet before the sign. The Engineer may order adjustments to the sign angle during the initial installation.

3.3 VMS FOUNDATIONS

A. Excavation
   1. Perform as described in Sections 02466 and 13551.

B. Anchor Bolts:
   1. Provide anchor bolt template during installation of anchor bolts. Fabricate the bolt template of ¼ -inch thick minimum steel plate, similar to anchor plate details. Match drill to each base plate.
   2. Fill the void between the base plate and top of foundation with non-shrink grout after completing the sign erection.

C. Earthwork
   1. Place compacted embankments prior to drilling.
   2. Form caissons to a minimum of 6 inch below the ground surface. Refer to Section 02466. Place compacted backfill before erecting post.

3.4 VMS SUPPORTS

A. Structural Pipe:
   1. Provide hand holes for the overhead pipe frame on one side only.
   2. Locate inserts at the bottom of the mast arm . Weld 1 ½ -inch diameter insert in each hole. Thread inserts before galvanizing and provide galvanized plugs.
   3. Rake post as necessary during sign erection using leveling nuts to level the sign panels. At final position, create a snug tight condition by wrench tightening both top and bottom anchor bolt nuts against the base plate until full contact is made. Tighten top nuts one-sixth turn past snug tight and retighten lower nuts to maintain full contact.

B. All Other Structural Steel:
   1. Use one sign-mounting bracket at each sign support. See sign fabricator's drawings for number and location of supports (i.e., channels or Z-bracket).
   2. Pre-tension steel rod to 11,000 lbf.
   3. Sign placement on horizontal member may be adjusted up to $^{3}/_{8}$ inch upward for VMS platform to match catwalk elevation.

C. Earthwork:
   1. Place and compact backfill prior to erecting supports.

3.5 ATMS CABINET

A. Install ATMS cabinet according to Section 13555.

3.6 TESTING AND ACCEPTANCE

A. Successfully complete the following tests:
   1. Cable and Conductor Test: Obtain UDOT's newest version of the ATMS Cable and Conductor Test from the UDOT Web site. Refer to http://www.udot.utah.gov/index.php/m=c/tid=719.
   2. Local Field Operations Test: Obtain UDOT's newest version of the Variable Message Sign Local Field Operations Test form from the UDOT Web site. Refer to http://www.udot.utah.gov/index.php/m=c/tid=719.
      a. Conduct the Local Field Operations test after the Cable and Conductor test has been successfully completed and the Cable and Conductor Test Report has been approved by the Engineer.
      b. Verify physical construction has been completed in accordance with the plans and specifications and that the connecting cabling has been properly installed.
      c. Furnish all equipment, appliances, and labor necessary for the test.
   3. Acceptance Tests: Refer to Section 13595.

END OF SECTION